BIOLOGY OF GASTROPHYSA CYANEA MELSH.

(COLEOPTERA: CHRYSOMELIDAE)

FRED A. LAWSON,[1]
Department of Zoology and Entomology,
Ohio State University

One of the earliest insects to resume activity in the spring is a bright metallic blue or green leaf beetle which feeds on various species of *Rumex*. They have been observed feeding and ovipositing as early as April 3rd in the locality of Columbus, Ohio. This paper presents the life history and some of the external morphological characteristics of the larvae and adults.

SYSTEMATIC POSITION AND PREVIOUS WORK

This beetle is a leaf feeding member of the subfamily Chrysomelinae, family Chrysomelidae, order Coleoptera.

The taxonomy of the genus is somewhat confused. Leng (1920) lists the genus as *Gastroidea* Hope, with *Gastrophysa* Redt. as a synonym, giving as authority the *Coleopterists Manual*, London, III, 1845, p. 164. Barber and Bridwell (1940) indicate that the genus should be known as *Gastrophysa* Chevrolat, as was adopted by Redtenbacher; these authors base their opinions on the third or 1837 edition of the *Dejean Catalogue of Coleoptera*.

The specific name *cyanea* was set up by Melsheimer in 1847. In his description the color is listed as "blue . . . scutellum green; elytra . . . with a green reflection;" this does not appear to definitely limit the species as to color, but since the word "blue" follows immediately after the species name in the description, the species *cyanea* probably should be considered as blue in color. A definite green form occurs in various parts of the country, however; McCracken (1906) after lengthy studies, concluded that the species contains both blue and green forms with the blue being genetically dominant. Blatchley (1910) describes *G. cyanea* as "Oblong-oval. Uniform brilliant green or blue."

Leng lists a subspecies or variety, *caesia* Rogers, from California, which is green. Goe (1918) listed his insects only as *Gastroidea caesia;* this work was done in Oregon and he may have been working with the green form of *G. cyanea*.

In this study, both blue and green forms have been used; they are considered hereafter as a single species, since there are no observed differences in habits or immature stages and none in the adults except color. Crosses were not made.

The previous life history work on this insect is rather sketchy. Girault (1908) records "the general outline of the cycle, together with a description of the egg." The incubation period and duration of larval stages are recorded in days and hours; the food plant is listed as "a species of *Rumex*." Color was not mentioned. The general paper by Goe (1918) contains notes on oviposition, incubation, and larval development. McCracken (1906) reared many of these beetles; however, the primary interest was in color and life history records were taken only in an incidental manner.

DISTRIBUTION AND ECONOMIC IMPORTANCE

This beetle appears to be generally distributed in the United States and southern Canada. Leng (1920) lists *G. cyanea* as occurring from California to Indiana, and

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in Arizona and Connecticut. Goe (1918) stated that it occurred abundantly in the Pacific Northwest. Specimens have been collected personally in Ohio, Kansas, and Arkansas. There are numerous records from Ohio.

The beetles may become quite abundant in localized areas but are not found in every stand of the common *Rumex* species. Around Columbus they were found most often on *R. obtusifolius* but the points of infestation were rather widely separated. Flight was not observed and could not be induced, indicating that the insect probably increases its range only by walking.

Outside of occasional feeding on rhubarb (Essig & Hoskins, 1944) (Goe, 1918), these beetles are of very little economic importance. Their short period of activity and highly localized distribution prevent their being of much value as a natural control of the *Rumex* species which serve as host plants. Their slight occurrence on rhubarb probably does not make necessary the use of control measures.

Rearing Methods

Beetles were collected in the field and kept in Petri dishes for feeding and oviposition; fresh leaves of *Rumex obtusifolius*, *R. crispus*, and *R. altissimus* were supplied daily as food. Adults were also caged on plants of all three species in order to observe feeding and oviposition habits.

Larvae were reared in petri dishes, on potted plants, and on plants growing outside the insectary. Second and third instar larvae ate large quantities of food. As the feeding period ended, the petri dishes were filled two-thirds full with loosely packed soil for pupation. This allowed observation of the actual pupal period within the cell.

Feeding and Oviposition Habits

Adult Feeding

The adults usually make their first appearance on the lower surface of the leaves of the host plant. The preoviposition feeding period varies in length with the average daily temperatures following spring emergence. The overwintered adult females may live four to eight weeks.

The beetles feed at first on small patches of the lower surface of the leaf; later they feed along the margin, eating inward a short distance and progressing along the edge at the same time. Individually they do not consume a great amount of food.

Oviposition

Eggs normally are laid in compact groups on the lower surface of the leaves of the host plant, with most masses being placed along the midrib and often near the base of the leaf. If the beetles are crowded, they may deposit the eggs elsewhere.

The number of eggs per group averaged about 40; the maximum was more than a hundred. Field collected caged females averaged 1135 eggs each; the range was from 808 to 1435.

Larval Feeding

The larvae are also leaf feeders and develop rapidly when temperatures are favorable. The newly hatched larvae are pale yellow with black heads; they soon become entirely black. The first hatching larvae have been observed feeding on the other eggs in the group, although this does not appear to be of common occurrence. There are two ecdyses between hatching and pupation, with a resting or prepupal period preceding the pupa.

The larvae wander out over the under surface of the leaf almost immediately after hatching, settle in compact groups, and eat small holes in the lower layer of the leaf tissue. As the larvae feed, their black bodies enlarge, the thin pleural and intersegmental membranes become tightly stretched between the sclerotized plates and larvae become yellowish green in color. The upper surface of the

leaf may at times appear gray and translucent over the areas where the larvae have fed heavily.

The caudal end is usually anchored to the leaf by the anal sucker before the molts occur. The black exuvium is left upright on the lower surface of the leaf; this furnishes a good check on larval molting.

The second instar larvae also become black soon after molting, and they tend toward individual rather than group feeding. During this period these larvae spread out over the leaf and to other portions of the host plant, feeding and becoming lighter in color. The tissue of the leaf is destroyed, leaving only the branching framework of veins; this type of injury often resembles that of a skeletonizer.

The second molt also occurs on the under side of the leaf and is not unlike the first. The third instar larvae spread rapidly over the entire plant and to adjoining plants if they have not previously completed the movement. Leaves are often stripped down to the midrib and green seed stalks are denuded; in a stand of limited size, a large population of this insect usually reduces each plant to a stubby brown stalk with a few ragged leaf remains.

TABLE I

G. cyanea. DURATION OF INCUBATION PERIOD, 1947

TEMPERATURE °C.	INCUBATION PERIOD—DAYS			NO. EGGS
	Average	Maximum	Minimum	
10.0 - 10.9	13.64	19	12	1,180
11.0 - 11.9	10.28	11	10	106
12.0 - 12.9	13.66	14	13	233
13.0 - 13.9	.....	...	...	.....
14.0 - 14.9	7.41	8	7	261
15.0 - 15.9	7.14	8	7	386
16.0 - 16.9	6.28	7	6	1,498
17.0 - 17.9	5.53	6	5	551
Total.....	.....	.....	.....	4,215

The mature larvae are yellowish green and measure about half an inch in length when completely fed. After only a few days of feeding, the third instar larvae bury themselves in the soil, usually at depths of less than half an inch; here a pupal cell is formed. The larva assumes a somewhat crescentis shape, becomes more or less immobile, and rests for several days. The pupal stage occurs in this cell.

Duration of Stages

The incubation period for 4215 eggs of *G. cyanea,* with temperatures ranging from 10° to 18° C. varied from 5 to 19 days (see Table I). The average incubation period for all observed series of eggs was 9.3 days at an average temperature of 13.2° C.

These eggs were deposited over a period of 6 weeks, from April 16 to May 27 inclusive. The great number of eggs hatching with an average incubation temperature of 10.0–10.9° was due in part at least to a cold wave which occurred during the early stages of this life history study. Hatching was delayed for several days; a relatively small rise in temperature then initiated the emergence of many new larvae.

The duration of all pre-imaginal (egg through pupal) stages may be summarized in the following table:

TABLE II

G. cyanea. DURATION OF PRE-IMAGINAL STAGES (DAYS), 1947

	STAGE					
	Egg	1st Instar	2d Instar	3d Instar	Pre-pupa	Pupa
Maximum.....	19	12	5	5	6	9
Minimum.....	5	3	3	2	2	4
Average.....	9.3	4.5	3.8	3.1	4.5	6.3
Totals*...	4,215	1,937	1,657	1,363	969	812

*This represents total number individuals in each stage.

The correlation of post-embryonic pre-imaginal stages with temperature is presented in Fig. 1. In this graph is shown the average time of development and the average temperature during that period for all larvae hatching on a given date. For instance, on the chart below, all larvae hatching on May 1st became adults after an average time of 30.26 days; the average temperature during this period was 55.7° F.

DESCRIPTION OF STAGES

The following descriptions of the stages are intended for comparative rather than taxonomic purposes; the descriptions are given as a means of recognition of this Chrysomelid species and do not necessarily separate it from others in the same genus.

Egg

Length, .93 mm.; width, .46 mm. These are averages based on measurements of 100 eggs taken from different egg masses.

Color light orange yellow, liberally to sparsely speckled with minute red particles. Shape elongate-oval, ends rounded, concave-convex in lateral view. Surface smooth, simple, and sticky when deposited; micropyle inconspicuous. Clear area in one end when deposited; this disappears as the embryo develops or increases in size when the egg is not fertile. Ocelli, mouthparts, claws, and spines show black through the chorion prior to eclosion.

Larva

Larvae are dark brown to black, becoming gray with approach of ecdysis; body widest at about 4th abdominal segment, tapering gradually cephalically and more rapidly caudally; body surface finely spinose, densely so in third instar, moderately in 1st and 2nd; body linear after hatching and each ecdysis, becoming crescentic in lateral aspect after feeding, with highest point over metathoracic and first abdominal segments.

Head dark brown to black, ovate-spherical, wider than deep, with mouthparts directed downward; epicranial and frontal sutures prominent; ocelli six, four slightly above and caudal of antennal fossae and two below and slightly forward; antennae 3-segmented, with accessory digit distally on second, beside the small third segment, which bears three tiny bristles apically; mandibles 5-toothed, palmate and cupped, mola absent; labium simple, fleshy, with "W" shaped darker sclerotized area extending cephalically between and partially around the bases of

the 2-segmented palpi; maxillae large and fleshy, bearing a single mala or lobe in place of galea and lacinia; mala dark, sclerotized, and bearing a row of short stout bristles on mesal surface; maxillary palpi 4-segmented; labrum present, hinged, short, wide, notched, and bearing a transverse row of setae just below the center line; clypeus short, with spines along lower margin.

Thorax half or more than half as long as abdomen; mesal tubercles bear single seta; others have one or more setae; meso- and metathoracic tubercles prominent, contain eversible glands and bear two setae each; prothoracic shield present, large, with marginal row of setae cephalically and scattered setae elsewhere; spiracle large, on mesothorax, situated on forward edge of segment laterally, adjoining tubercles just above base of leg.

Abdomen rounded, tapering caudally; all tubercles bearing 2 setae except dorsal on 7th segment; glands on segments 1 to 7 located in tubercles forming dorso-lateral row (3rd and most prominent row from dorso-meson) in 2nd and 3rd instars;

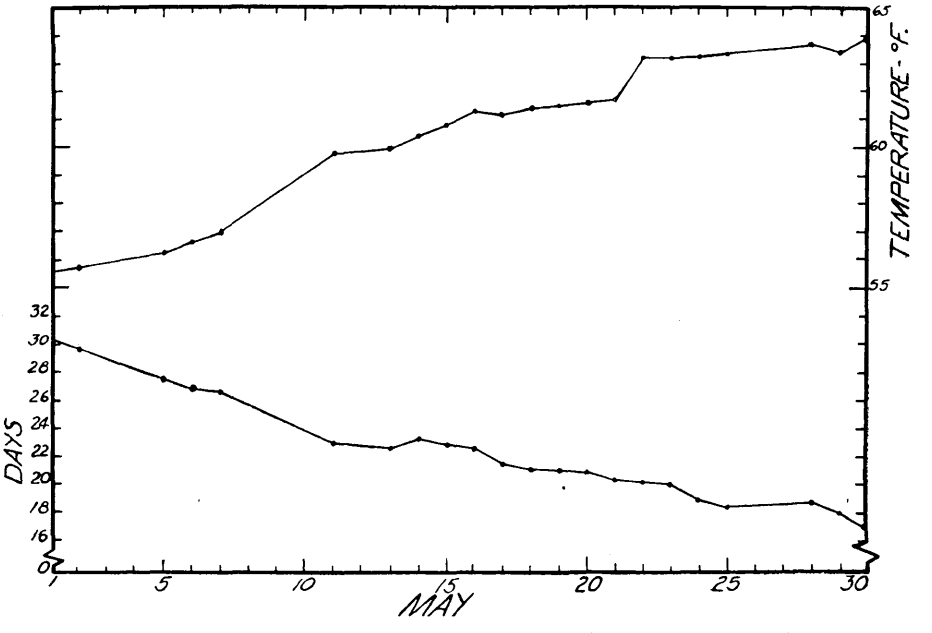
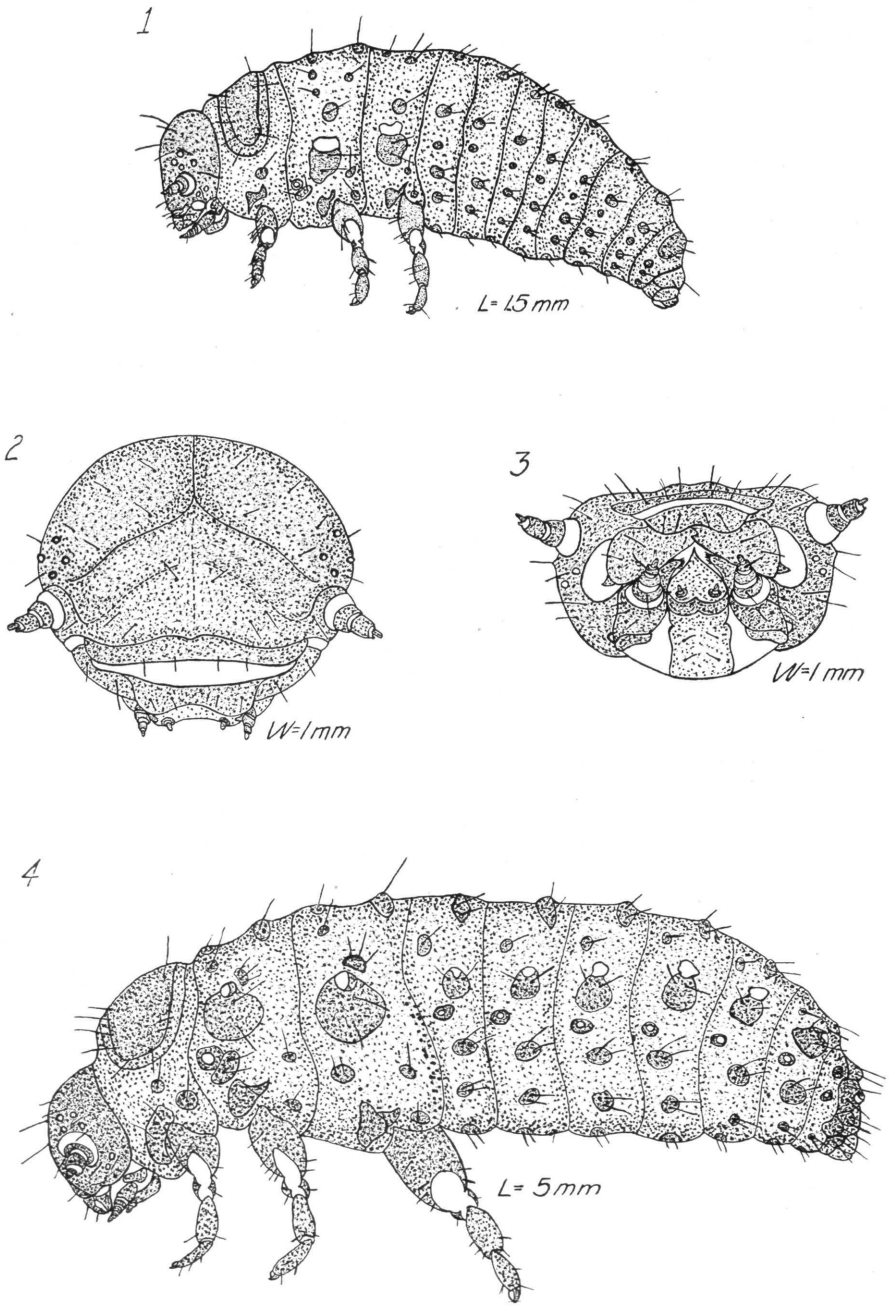


FIG. 1. *G. cyanea.* Correlation of Stages with Temperature, 1947.

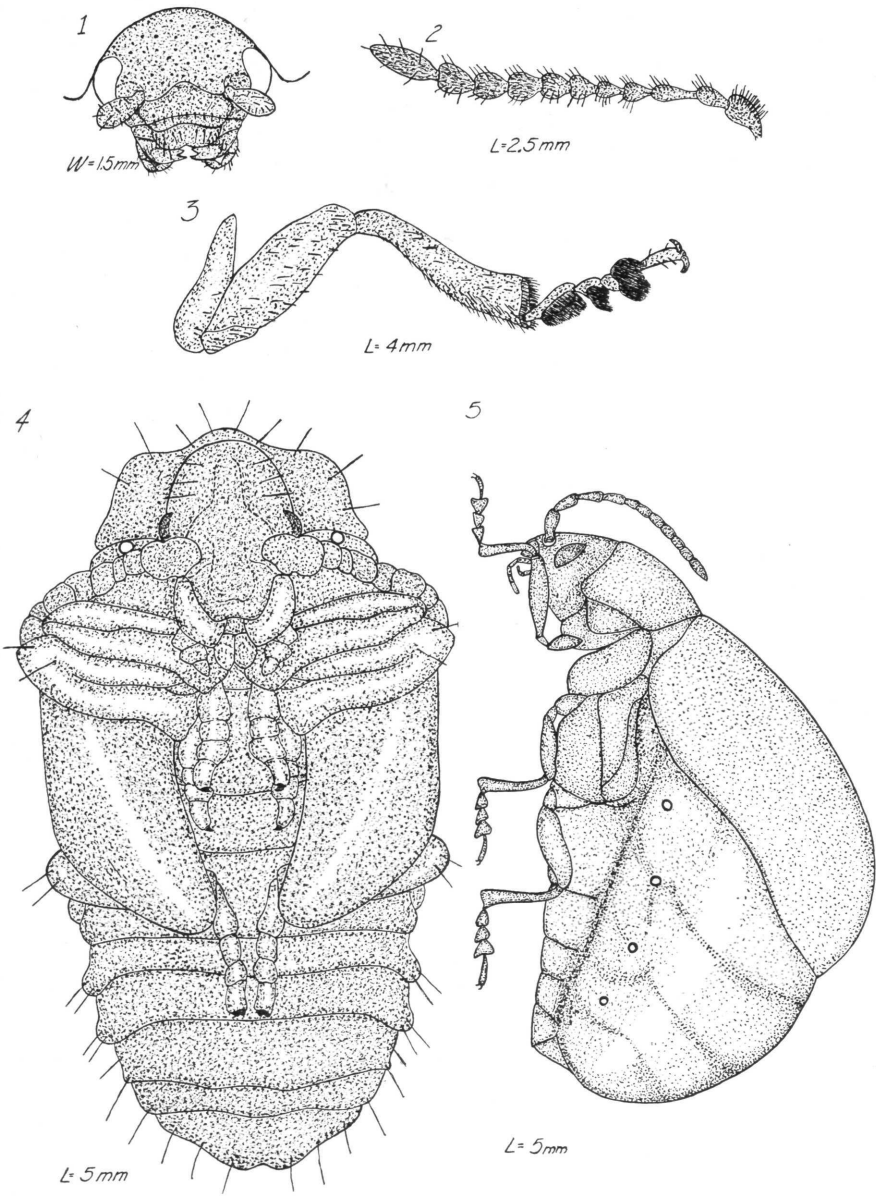
glands are present on same segments in 1st instar but are very small and apparently not eversible; two mesal tubercles on segment 7 fused into a single large one bearing 4 setae; 8th segment with no centrally located tubercle but with 4 setae located mesally along the caudal margin; 9th segment without tubercles, but with a marginal row of setae caudally, and somewhat shield-shaped; 10th segment inconspicuous, bearing anal sucker, which contains anal opening; spiracles annular, forming lateral row on segments 1 to 8 inclusive, located just below glandular tubercles; only two rows of tubercles present between spiracles and dorso-meson in 1st instar; 3 rows present in other instars.

Legs medium in length, 5-segmented, slightly elbowed at joints; coxa longest segment, broad, heavy; trochanter short, triangular laterally and open behind; femur short, thick, and shorter mesally; tarsus one-segmented, ending in a single claw which is situated beside a soft pad or pulvillus.



Gastrophysa cyanea M.

FIG. 1. 1st instar larva, side view. FIG. 2. Head, front view, 3rd instar larva. FIG 3. Head, ventral view, 3d instar larva. FIG. 4. 3d instar larva, side view.



Gastrophysa cyanea M.

FIG. 1. Head, adult, front view. FIG. 2. Antenna of adult. FIG. 3. Leg of adult. FIG. 4. Pupa, bottom view. FIG. 5. Female, side view.

Head capsules of 50 larvae of each instar were measured with an ocular scale micrometer. The widths of the head capsules by instar were as follows:

Instar	*Range (mm.)*	*Average (mm.)*	*Ratio of Increase*
1st	.45– .50	.47	
			.63
2d	.68– .87	.75	
			.70
3d	.98–1.17	1.07	

Pupa

Pupa yellow, exarate, more or less curved in lateral outline; appendages free, movable, and visible; head not visible from above; mouthparts directed caudally; pronotum turned ventrally, bearing two transverse rows of setae, cephalic and caudal on the segment; single setae on tubercles of thoracic segments; thoracic spiracle annular, on mesothorax at lateral base of pronotum; abdomen with 6 rows of tubercles (in 3 pairs of rows) visible dorsally; mesal pair of rows extending from 1st to 6th segments inclusive, spines on each tubercle large, 2 in number; lateral rows on segments 2 to 8 inclusive, tubercles most prominent, with 2 prominent setae on each; intermediate rows near to lateral rows, tubercles smaller, each with 2 less conspicuous setae; spiracles annular, visible dorsally on segments 1 to 6 inclusive; spiracles on segment 6 not so heavily sclerotized and less prominent than on other segments; row of spircales situated between lateral and intermediate rows of tubercles; abdominal segments 10 in number from dorsal aspect.

Adult

A short description of the adult of this species is given by Blatchley (1910).

SUMMARY

The dock leaf beetle, *G. cyanea* Melsh., is an insect which overwinters as an adult, emerges very early in the spring, and feeds briefly but heavily on species of *Rumex* during a single generation of growth.

The abdomen of the female becomes greatly distended and she deposits many eggs. Delayed oviposition on the part of different females causes all stages to be present in late May and early June.

The larvae consume quantities of leaf tissue, then retire to just below the surface of the soil for a brief prepupal resting period, which is followed by pupation. The adults which emerge from these pupae occasionally appear above-ground for a brief period of feeding, but in general they remain within the pupal cell.

This insect is of little or no economic importance in Ohio.

LITERATURE CITED

1. **Barber, H. S.,** and **J. C. Bridwell.** 1940. Dejean Catalogue Names (Coleoptera). Bul. Brook. Ent. Soc., 35(1): 1–12.
2. **Blatchley, W. S.** 1910. Coleoptera of Indiana, pp. 1159–1160.
3. **Essig, E. O.,** and **W. M. Hoskins.** 1944. Insects and Other Pests Attacking Agricultural Crops. Cal. Agr. Ext. Serv. Cir. 87, p. 109.
4. **Girault, A. A.** 1908. Outline Life History of the Chrysomelid Beetle, *Gastroidea cyanea* Melsheimer. Psyche, 15: 6–9.
5. **Goe, Milton T.** 1918. Life History and Habits of *Gastroidea caesia* Rog. (Col.) Ent. News, 29: 224–226.
6. **Leng, Charles W.** 1920. Catalogue of the Coleoptera of America, North of Mexico, pp. 295, 416.
7. **McCracken, Isabel.** 1906. Inheritance of Dichromatism in *Lina* and *Gastroidea*. Jr. Exp. Zool., 3: 321–336.
8. **Melsheimer, Frederich E.** 1847. Descriptions of new species of Coleoptera of U. S. Proc. Acad. N. S. Phila., III, p. 175.